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DEPARTMENT OF HEALTH  
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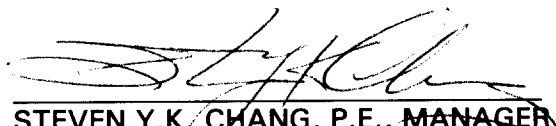
**POLICY UPDATE**


**Risk-Based Corrective Action and Decision Making at Sites With  
Contaminated Soil and Groundwater  
and  
Technical Guidance Manual for Underground Storage Tank Closure  
and Release Response  
and  
Technical Guidance Manual for the Implementation of  
The Hawaii State Contingency Plan**

TO ALL INTERESTED PARTIES:

This policy update introduces the requirement for the sampling and analysis of Methyl tertiary-Butyl Ether (MtBE) at petroleum release sites where the regulated compound released is gasoline. This policy update also amends the Tier 1 lookup Tables in the Hawaii Department of Health *Risk-Based Corrective Action and Decision Making at Sites With Contaminated Soil and Groundwater* document to include Tier 1 soil and groundwater Action Levels for MtBE. **This policy update is effective January 1, 1999.**

Please bring this policy update to the attention of anyone you know who may have an interest in this matter. Should you have any questions regarding this policy update, please contact the Underground Storage Tank Section at (808) 586-4226.

  
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Date: OCT 16 1998

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## **POLICY STATEMENT**

### **Requirement for Sampling and Analysis of Methyl tertiary-Butyl Ether in Soil and Groundwater at Underground Storage Tank Closure and Release Investigation Sites**

#### **SUBJECT**

Methyl tertiary-Butyl Ether (MtBE) is a synthetic chemical which is a widely used blending component in gasolines. MtBE has been used in gasoline formulation since 1979 and is often referred to as an oxygenate as it adds oxygen to the fuel. MtBE was initially used in gasoline at concentrations up to 8% (by volume) as a replacement for tetraethyl lead to enhance the octane level in gasoline (USEPA, 1998A). However, more recently, as a result of the Clean Air Act Amendments of 1990, MtBE usage has grown in response to the requirement for oxygenated fuels or reformulated gasoline (RFG) in locations where atmospheric concentrations of ozone or carbon monoxide exceed national ambient air quality standards. Oxygenates are currently used in 30% of the gasoline sold in the United States with MtBE used in about 84% of RFG supplies (USEPA, 1997). Concentrations of MtBE in octane enhanced or RFG range from 2 to 15 percent (van de Gried and Kavanaugh, 1996). MtBE is a volatile chemical, and as a result, the major source of exposure is from air. However, there have been reported incidences of drinking water contamination by MtBE with the source of contamination being leaking underground storage tank (LUST) systems and pipelines for gasoline products (USEPA, 1997).

MtBE is a volatile, colorless liquid with a turpine like odor. It has a low molecular weight (88.15 g/mol), high volatility (vapor pressure 245 mm Hg at 25° C) and a high water solubility (51.26 g/l) which is more than an order of magnitude higher than the solubilities of benzene, toluene, ethylbenzene, and xylene compounds (BTEX) (Budavari et al. 1989, as cited in EPA, 1994). The octanol-water partition coefficient ( $\text{Log } K_{ow}$ ) for MtBE which describes the tendency of a chemical to associate with organic matter versus dissolving into water is reported as 0.94 to 1.16 which is near the low end of ranges discussed in the literature. The low  $\text{log } K_{ow}$  of MtBE indicates that this chemical will not strongly sorb to organic matter in surface or subsurface soils, but will be washed or leached away with rainwater or other water sources. Once MtBE is in groundwater, due to its solubility, it can move at almost the same velocity as the water. Consequently, as a result of its more rapid movement through the subsurface and higher solubility, MtBE groundwater plumes will typically exceed in size the plume of co-released BTEX contaminants in groundwater. In addition, MtBE persists in groundwater under both aerobic and anaerobic conditions because it resists physical, chemical and microbial degradation (Barker and others, 1990; Suflita and Mormile, 1993;

Hubbard and others, 1994; Mormile and others, 1994; Yeh and Novak, 1994 as cited in USGS, 1995). As a result, MtBE is considered a significant ground-water contaminant because of the above described mobility and persistence.

LUST cases on the U.S. Mainland have occurred in which MtBE has impacted drinking water supplies. A recent and well publicized case involved the Santa Monica well field in California. The City of Santa Monica was forced to close the well field and use alternative sources of water supply for the community. Concentrations of MtBE were as high as 590  $\mu\text{g/l}$  (van de Grind and Kavanaugh, 1996). As a result of the concern regarding MtBE as a groundwater contaminant, approximately 23 states have required UST related MtBE sampling and/or groundwater cleanup levels (USEPA, 1998A).

The Human Health and Criteria Division of the U.S. EPA Office of Water recently developed an Advisory document for MtBE titled *Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis of Methyl Tertiary-Butyl Ether (MtBE)* dated December 1997. The Advisory recommends concentrations of MtBE in drinking water be kept in the range of 20 to 40  $\mu\text{g/l}$  or below to protect consumer acceptance of water supplies and provide an adequate margin of safety from toxic effects (USEPA, 1997).

## **BACKGROUND**

Based upon the U.S. Mainland findings that MtBE is being found as a contaminant at LUST sites at a greater frequency than expected, and at locations where it had not been anticipated, DOH decided to inquire with local refineries, major gasoline retailers, and the Department of Defense (DoD) as to the MtBE content of the gasoline products they produced or stored in Hawaii. The purpose of this survey was to determine the likelihood of MtBE's occurrence in gasoline used in Hawaii. This information would be used to assist in deciding whether to include MtBE as a required analyte at UST closure and release response activities. In September 1997, the DOH sent a letter of inquiry to the refinery operations located in the state (BHP and Chevron USA), major gasoline retailers without refineries in the state (Shell, Texaco, Aloha Petroleum, and Unocal), and the DoD regarding their knowledge of MtBE content in their gasoline products produced or stored in Hawaii.

The findings of the inquiry indicated that MtBE had in the past been used in the formulation of gasoline at an Oahu refinery. All major gasoline retailers and the DoD facilities in Hawaii have most likely stored and sold gasoline produced by this refinery. It was also learned that importation of gasoline into Hawaii which contained MtBE had occurred as recently as 1997. Furthermore, several responses indicated that they did not possess the records to either confirm or deny the

existence of MtBE in their gasoline either currently or beyond a certain point in the recent past.

Since the time of the survey, the DOH has reviewed a number of UST release response reports for tanks located in Hawaii where MtBE analysis was performed and reported in the site assessment findings. The analytical findings have indicated on a number of occasions the presence of MtBE in soil and groundwater.

In addition to consideration of current and past usage of MtBE, there exists an uncertainty as to: (1) whether refineries on Oahu might change their gasoline formulation at some time in the future to include MtBE; and (2) the possibility that future importation of gasoline to Hawaii might contain MtBE.

The past usage and the uncertainty of future usage of gasoline containing MtBE was sufficient information for DOH to determine that inclusion of the analysis of MtBE in soil and/or groundwater for UST release investigations was appropriate.

## **POLICY**

### **MtBE Sampling Required**

DOH requires that investigative efforts for UST release response, when gasoline was stored in the leaking UST, include the analysis of MtBE in soil or groundwater as appropriate. Attached as Appendix A to this Policy Update is a revised Table 7.2 "Recommended Chemical Analysis for UST Closure and Release Response" from the DOH document titled *Technical Guidance Manual for Underground Storage Tank Closure and Release Response* (TGM), dated August 1992, which indicates when sampling and analysis for MtBE is required.

If it is determined during tank closure that a release has occurred at a UST storing gasoline, either through observation or sample analysis (TPH-G), inclusion of MtBE in the release response investigation is required. Environmental sampling requirements for UST closure and release response are provided in the TGM. The reader should refer to this document for direction on when **soil and/or groundwater** sampling is required.

Due to the ability of MtBE to migrate very rapidly through the subsurface to groundwater, if other gasoline contaminants are detected in groundwater above Tier 1 action levels, MtBE should be added as an analyte for at least one cycle of sampling to determine its presence in groundwater, regardless of analytical results for MtBE in soil. In addition, DOH may request groundwater sampling at any site where conditions are such that DOH believes that soil characterization alone may not accurately determine the impact to groundwater from MtBE.

This sampling requirement is applicable to both new and existing remedial investigations, cleanups, and groundwater monitoring programs dealing with releases of gasoline from USTs. This policy is not applicable to LUST sites which have been previously successfully investigated and remediated and issued a "no further action" determination by the DOH. However, if DOH becomes aware of MtBE contaminated soil or groundwater that indicates the likelihood of a previously closed site as a source, DOH may require the evaluation of the site for soil and/or groundwater contamination by MtBE and remedial measures be taken, if necessary.

### Analytical Methodology

It is recommended that either EPA Method 8260B, EPA Method 8021B or EPA Method 8020 be used for analysis of MtBE in soil or groundwater. It is DOH's understanding through conversations with several consultants doing release investigation work in Hawaii that EPA Method 8020 is frequently used for analysis of BTEX compounds at UST release investigations. EPA Method 8020 has been replaced by EPA Method 8021B in the Final Update III (December 1996) of the SW-846 *Testing Methods for Evaluating Solid Waste* manual. EPA Method 8021B is a gas chromatography (GC) method that uses an electrolytic conductivity detector (ELCD) and photoionization detector (PID) to distinguish and quantify volatile aromatic and halogenated compounds. The major difference between EPA Methods 8020 and 8021B is the addition of the electrolytic conductivity detector (ELCD) for halogenated compounds to EPA Method 8021B. However, the use of the ELCD is optional and most likely won't be used in UST release investigations involving gasoline or diesel fuels as halogenated compounds are not a component of these substances. Therefore, for investigation of gasoline and diesel releases, EPA Method 8021B performs the same analysis as EPA Method 8020, a GC utilizing a PID for analysis of volatile aromatic compounds. The addition of MtBE to the requested analysis performed and reported by EPA Method 8020/8021B should pose little or no additional cost (Hartman, 1997).

A significant concern with EPA Method 8020/8021B for MtBE analysis is the occurrence of false positives due to coelution of several alkane compounds that are present in gasoline in large quantities (Hartman, B., 1997). A recent finding by Lawrence Livermore National Laboratory (*An Evaluation of MTBE Impacts to California Groundwater Resources*, dated June 11, 1998) was that in the presence of high concentrations of non-oxygenated gasoline (50,000 µg/l) in water samples, EPA Method 8021B yielded false-positive results for all oxygenates tested including MtBE. The Lawrence Livermore National Laboratory (LLNL) report concluded that EPA Method 8021B for groundwater samples was a "...very conservative monitoring tool due to the lack of false-negative results, and its tendency for overestimation of analyte concentrations and false-positive

misidentifications." The issue of false positives may be even greater for soil vapor or soil samples than groundwater (Hartman, B., 1997).

To address the potential occurrence of false positive results for MtBE resulting from EPA Method 8020 or EPA Method 8021B, it is recommended that EPA Method 8260B be used for confirmatory analysis on positive testing samples. EPA Method 8260B is a gas chromatography method which uses a mass spectrometer (MS) detector. EPA Method 8260B has replaced EPA Method 8240 in the Final Update III (December 1996) of the SW-846 *Testing Methods for Evaluating Solid Waste* manual. MtBE would need to be requested as a target compound for this method. Samples which test positive by EPA Method 8020 or EPA Method 8021B will be considered valid unless confirmation analysis by EPA Method 8260B demonstrates otherwise. If MtBE was not detected in soil or groundwater by EPA Method 8020 or EPA Method 8021B, confirmation analysis is not required.

### Tier 1 Action Levels for Groundwater

#### 1. Drinking Water Source Threatened

The Tier 1 Action Level for MtBE in an aquifer used for or potentially used for drinking water is twenty micrograms per liter (20  $\mu\text{g/l}$ , or 20 ppb).

The U.S. Environmental Protection Agency (EPA) Office of Water issued an advisory statement in December, 1997, for MtBE in drinking water. Available studies led EPA to conclude that a "threshold" concentration of 20-40  $\mu\text{g/l}$  in drinking water would not generate complaints from most people about MtBE's unpleasantly bitter taste and odor.

No comprehensive studies have been conducted in humans to evaluate the health effects of MTBE via ingestion. In the past, MTBE has been administered as a therapeutic agent for the treatment of gallstones, however this therapy is no longer practiced. A drinking water equivalent no-observed-adverse-effect level in humans has been established at 3,500 micrograms per liter of water. This value was derived from animal studies and was selected to prevent evidence of non-cancer, kidney toxicity. The unpalatable taste and odor generated by 20-40 micrograms of MtBE per liter of water would tend to protect against a kidney-damaging level of consumption. This supports the idea of using the lower taste-and-odor (organoleptic) concentration as the Tier 1 Action Level for groundwater contamination.

This practice would be analogous to the National Secondary Drinking Water Regulations (NSDWR). The EPA promulgated the NSDWR for drinking water contamination by certain substances (e.g., copper, iron, and sulfate) which affect taste and odor at lower levels than the concentrations which affect health.

EPA is currently reviewing the database to determine a carcinogenicity classification for MTBE. Definitive evidence exist for MTBE carcinogenicity via inhalation in animal studies, however few studies have been conducted via ingestion. The weight of evidence suggests that MTBE is an animal carcinogen, and poses a carcinogenic potential to humans. MTBE is metabolized in the liver to formaldehyde (Probable Human Carcinogen) and t-butyl alcohol (Insufficient Evidence for Carcinogenicity). EPA continues to review new data in an effort to establish a quantitative cancer potency estimate for MTBE. Use of the only available chronic animal bioassay examining MTBE exposure via ingestion results in a slope factor of  $4 \times 10^{-3} \text{ (mg/kg-day)}^{-1}$ . The results of this study (and the potency factor derived therefrom) have been questioned because of methodologic and interpretation inconsistencies. Nevertheless, use of that potency factor results in a lifetime cancer risk from consuming water that contains 20 ug/L would be one excess cancer case per one million people.

## 2. Non-Drinking Water Source Aquifer

The Tier 1 Action Level for MtBE in a non-drinking water aquifer is 202 milligrams of MtBE per liter (mg/l). This action level is intended to be protective of aquatic ecosystems should contaminated groundwater migrate or otherwise be discharged into a body of surface water.

There is no National Ambient Water Quality Criteria to protect aquatic organisms from MtBE. MtBE evaporates rapidly from surface water, which in itself is protective.

ENSR Corporation and ARCO conducted subchronic toxicity tests on two daphnia species (*Ceriodaphnia dubia* and *daphnia magna*) and two fish (fathead minnow and trout). Because of MtBE's volatility, exposures to these species were conducted in enclosed test chambers with minimal head space or under flow-through conditions.

The subchronic exposure test on *Ceriodaphnia* was conducted until 60% of the control organisms had produced three broods of offspring. The no-effect concentration was 202 mg/l. As a comparison, the fathead minnow subchronic exposure lasted for 7 days, and the no-effect concentration was 234 mg/l.

In all tests, the invertebrates were more sensitive than the fish species. In the

acute-exposure tests on Ceriodaphnia which lasted 48 hours, the no-effect concentration was 348 mg/l. The acute-exposure test on the fathead minnow lasted 96 hours, with a no-effect concentration of 979 mg/l. (Stubblefield and others, 1997).

The lowest no-effect concentration in all these tests was 202 mg/l in the subchronic exposure of Ceriodaphnia. At a calculated level of 204 mg/l (95% confidence interval), 25% of the Ceriodaphnia exposed to MtBE were observed to have decreased reproduction. Not only is this a small safety margin, but also these tests were very recent and have not yet been repeated. Therefore, 202 mg/l is a temporary advisory level.

As there is a five order-of-magnitude difference between the Tier 1 action level for non-drinking water aquifers (202mg/l) and drinking water aquifers (0.020 mg/l), where non-drinking water aquifers either overlie drinking water aquifers, or potentially are in hydrologic communication with a drinking water aquifer, an evaluation may be required by DOH to demonstrate that the drinking water aquifer will not be adversely impacted by migration of groundwater contaminated with MtBE from the non-drinking water aquifer. (See DOH Policy Update titled *Determination of Groundwater Utility at leaking Underground Storage Tank Sites*, dated September 19, 1995 for further discussion on this matter.)

#### Tier 1 Action Levels for Soil

DOH developed Soil Action Levels (SALs) for MtBE by modeling the potential for residual contamination to be leached from the vadose zone and carried downward to groundwater using the SESOIL computer application (General Services Corporation, 1993, Version 1.07). Table 1-1a and Table 1-1b provide the Tier 1 Lookup Table SALs for both drinking water and non-drinking water aquifers. Appendix B provides Tier 1 SESOIL derived SALs for groundwater protection concerns based upon depth to groundwater as measured from the base of the impacted interval. In addition, Appendix B provides supporting data for Tier 1 SALs generated by SESOIL. A direct-exposure SAL for MtBE was not developed by DOH as the appropriate toxicity values were not available from the June 1998 EPA Region 9 Preliminary Remediation Goals (PRGs) Report. Should toxicity values become available at a future date, a direct-exposure SAL will be calculated for MtBE. The toxicity values used in the PRGs are consistent with the EPA "IRIS" and "HEAST" data bases. The reader should refer to the DOH document titled *Risk-Based Corrective Action and Decision Making at Sites with Contaminated Soil and Groundwater Volumes I and II*, dated December 1995 (revised June 1996) for specific information on the development and application of direct-exposure and groundwater protection SALs for use with site investigation and cleanup.



## Tier 1 Lookup Tables

**Table 1-1a (cont.) Tier 1 Action Levels for soil and groundwater:  
Rainfall  $\leq$  200 cm/yr**

RAINFALL $\leq$ 200CM/YEAR				
Contaminant	DRINKING WATER SOURCE THREATENED		DRINKING WATER SOURCE NOT THREATENED	
	Groundwater (mg/l)	Soil (mg/kg):	Groundwater (mg/l)	Soil (mg/kg):
MtBE	0.020	0.005 <sup>1</sup>	202	20

1. Actual SESOIL modeled SAL was 0.002 mg/kg

**Table 1-1b (cont.) Tier 1 Action Levels for soil and groundwater:  
Rainfall  $>$  200 cm/yr**

RAINFALL $>$ 200CM/YEAR				
Contaminant	DRINKING WATER SOURCE THREATENED		DRINKING WATER SOURCE NOT THREATENED	
	Groundwater (mg/l)	Soil (mg/kg):	Groundwater (mg/l)	Soil (mg/kg):
MtBE	0.020	0.005 <sup>1</sup>	202	20

1. Actual SESOIL modeled SAL was 0.002 mg/kg

The SALs for aquifers where drinking water sources are threatened, required some adjustment to account for the ability of laboratories using EPA Methods 8021B and 8260B to detect MtBE in soil at concentrations generated by the SESOIL model. DOH surveyed seven environmental laboratories to determine their ability to detect MtBE in soil at the calculated SALs for drinking water aquifers which ranged as low as 0.002 mg/kg. Most laboratories reported they could detect MtBE in soil at concentrations as low as 0.005 mg/kg using either EPA Method 8020, 8021B, or 8260B. Achieving 0.002 mg/kg did not seem consistently obtainable at this time. Consequently, the SAL was adjusted to 0.005mg/kg. This adjustment seems acceptable based upon the conservatism built into the Tier 1 SAL development approach.

## Tier 2 Site -Specific Evaluation of Impacted Soils

Similar to the other chemicals of concern listed in the DOH document *Risk-Based Corrective Action and Decision Making at Sites with Contaminated Soil and Groundwater*, revised June 1996, the user may choose to generate more site-specific "Tier 2" soil action levels using the same models and procedures incorporated into developing the Tier 1 SALs for MtBE. Please refer to Chapter 2 of the above mentioned document for the specific procedures to follow in the development of site specific Tier 2 SALs. Listed below in Table 2 are the physio-chemical constants used in Tier 1 SESOIL model. Please note that biodegradation constants were not used in the development of SESOIL derived Tier 1 SALs as MtBE is considered recalcitrant to biodegradation.

Table 2a. Physio-chemical constants used in Tier 1 SESOIL model

Constituent	Water Solubility (mg/l)	Diffusion Coefficient-air (cm <sup>2</sup> /s)	Henry's Constant (M <sup>3</sup> -atm/mole)	K <sub>oc</sub> (ml/g)	Molecular Weight
MtBE	51,260 <sup>1</sup>	0.09 <sup>2</sup>	0.00055 <sup>1</sup>	12.3 <sup>1</sup>	88.15 <sup>1</sup>

1. Source USEPA, 1994
2. Calculated using Fuller's Method described in the USEPA Superfund Exposure Assessment Manual, 1988

## REFERENCES

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APPROVED/~~DISAPPROVED~~



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Department of Health

Oct. 16, 1998

Date

# **Appendix A**

## **Table 7.2 Recommended Chemical Analysis for UST Closure and Release Response**

**Table 7.2 Recommended Chemical Analysis for UST Closure and Release Response**

SOURCE COMPOUND							ANALYTICAL CONSTITUENTS	SITE ACTIVITY
Unleaded gasoline	Leaded gasoline	Diesel	Jet Fuel	Kerosene	Fuel Oil	Waste Oil		
X	X						X	Closure
		X	X	X	X		X	
						X	X	
X	X	X	X	X	X		X	Release Response
							X	
		X	X	X	X	X	X	
						X	X	
						X	X	
	X					X	X	
						X	X	
						X	X	
						X	X	

# **Appendix B**

**SESOIL-generated Soil Action Levels**

**and**

**Supporting Data for Tier 1 Soil Action Levels (SALs)**

**Table B-1, SESOIL-generated soil action levels for groundwater-protection concerns at release sites that threaten groundwater that is a source of drinking water.**

DRINKING WATER SOURCE THREATENED - RAINFALL $\leq$ 200 cm/year							
Contaminant	Groundwater (mg/l)	Soil Action Levels <sup>1</sup> (mg/kg)					
		$> 5m^2$	$\geq 10m$	$\geq 20m$	$\geq 30m$	$\geq 40m$	$\geq 50m$
MtBE	0.020	0.005 <sup>3</sup>	0.005 <sup>4</sup>	0.005 <sup>5</sup>	0.005	0.006	0.009

DRINKING WATER SOURCE THREATENED - RAINFALL $>$ 200 cm/year							
Contaminant	Groundwater (mg/l)	Soil Action Levels <sup>1</sup> (mg/kg)					
		$> 5m^2$	$\geq 10m$	$\geq 20m$	$\geq 30m$	$\geq 40m$	$\geq 50m$
MtBE	0.020	0.005 <sup>6</sup>	0.005 <sup>7</sup>	0.005 <sup>8</sup>	0.005	0.008	0.011

1. Soil Action Levels listed by depth to groundwater in meters, depth to groundwater measured from base of impacted layer
2. Used in the development of Tier 1 lookup tables
3. Actual SESOIL modeled SAL was 0.002 mg/kg
4. Actual SESOIL modeled SAL was 0.003 mg/kg
5. Actual SESOIL modeled SAL was 0.004 mg/kg
6. Actual SESOIL modeled SAL was 0.002 mg/kg
7. Actual SESOIL modeled SAL was 0.003 mg/kg
8. Actual SESOIL modeled SAL was 0.004 mg/kg

**Table B-2, Tier 1, SESOIL-generated soil action levels for groundwater-protection concerns at release sites that do not threaten groundwater that is a source of drinking water.**

DRINKING WATER SOURCE NOT THREATENED - RAINFALL $\leq$ 200 cm/year							
Contaminant	Groundwater (mg/l)	Soil Action Levels <sup>1</sup> (mg/kg)					
		$> 5m^2$	$\geq 10m$	$\geq 20m$	$\geq 30m$	$\geq 40m$	$\geq 50m$
MtBE	202	20	30	40	51	61	91

DRINKING WATER SOURCE NOT THREATENED - RAINFALL $>$ 200 cm/year							
Contaminant	Groundwater (mg/l)	Soil Action Levels <sup>1</sup> (mg/kg)					
		$> 5m^2$	$\geq 10m$	$\geq 20m$	$\geq 30m$	$\geq 40m$	$\geq 50m$
MtBE	202	20	30	40	51	81	111

1. Soil Action Levels listed by depth to groundwater in meters, depth to groundwater measured from base of impacted layer
2. Used in the development of Tier 1 lookup tables

# SUPPORTING DATA FOR TIER 1 SOIL ACTION LEVELS (SALS)

Drinking water source threatened; annual rainfall = 200cm

Tier 1 SALS directly generated using SESOL (see text in HDOH RBCA document)

Contaminant	Target GAL	Depth to gw (m)	T-2 Time max gw impact	GW recharge (ml)	Calibrated				Contaminant		
					Target monthly flux (ug)	input soil conc. (ug/g)	T-1 Time scenario begins	Contaminant mass at T-1 (ug)	conc. at T-1(ug/g)	Date modeled	Modeled by
					flux (ug)	conc. (ug/g)	begins	mass at T-1 (ug)	Tier 1 SAL)	modeled	by
MTBE	0.02	5	1st yr, 5th mo	6,275	126	0.0021	1st yr, 1st mo	576	0.002	10/8/98	DH
MTBE	0.02	10	1st yr, 7th mo	7,255	145	0.0032	1st yr, 1st mo	873	0.003	10/8/98	DH
MTBE	0.02	20	2nd yr, 3rd mo	7,503	150	0.0058	1st yr, 2nd mo	1,038	0.004	10/8/98	DH
MTBE	0.02	30	2nd yr, 8th mo	5,860	117	0.008	1st yr, 2nd mo	1,490	0.005	10/8/98	DH
MTBE	0.02	40	3rd yr, 2nd mo	6,562	131	0.01	1st yr, 2nd mo	1,900	0.006	10/8/98	DH
MTBE	0.02	50	3rd yr, 7th mo	7,518	150	0.0135	1st yr, 2nd mo	2,605	0.009	10/8/98	DH

# SUPPORTING DATA FOR TIER 1 SOIL ACTION LEVELS (SALS)

Drinking water source threatened; annual rainfall = 400cm

Tier 1 SALS directly generated using SESOL (see text in HDOH RBCA document)

Contaminant	Target GAL	Depth to gw (m)	T-2 Time max gw impact	GW recharge (ml)	Calibrated				Contaminant		
					Target monthly flux (ug)	input soil conc. (ug/g)	T-1 Time scenario begins	Contaminant mass at T-1 (ug)	conc. at T-1(ug/g)	Date modeled	Modeled by
					flux (ug)	conc. (ug/g)	begins	mass at T-1 (ug)	Tier 1 SAL)	modeled	by
MTBE	0.02	5	1st yr, 3rd mo	12,189	244	0.0025	1st yr, 1st mo	499	0.002	10/8/98	DH
MTBE	0.02	10	1st yr, 5th mo	10,883	218	0.0036	1st yr, 1st mo	772	0.003	10/8/98	DH
MTBE	0.02	20	1st yr, 8th mo	9551	191	0.0048	1st yr, 1st mo	1,105	0.004	10/8/98	DH
MTBE	0.02	30	1st yr, 12th mo	8155	163	0.0067	1st yr, 1st mo	1,577	0.005	10/8/98	DH
MTBE	0.02	40	2nd yr, 4th mo	9526	191	0.01	1st yr, 1st mo	2,357	0.008	10/8/98	DH
MTBE	0.02	50	2nd yr, 9th mo	8402	168	0.014	1st yr, 1st mo	3,377	0.011	10/8/98	DH



# SUPPORTING DATA FOR TIER 1 SOIL ACTION LEVELS (SALS)

Drinking water source not threatened; annual rainfall = 200cm

Tier 1 SALS indirectly generated using SALS generated for drinking water sites (see HDOH RBCA document)

Contaminant	Tier 1 SAL for drinking-water source				Tier 1 SAL for drinking-water source not threatened		Date modeled	Modeled by
	Target GAL (mg/l)	Depth to gw (m)	threatened (mg/kg)	Conversion factor	threatened (mg/kg)			
MtBE	202	5	0.002	10,100	20		10/8/98	DH
MtBE	202	10	0.003	10,100	30		10/8/98	DH
MtBE	202	20	0.004	10,100	40		10/8/98	DH
MtBE	202	30	0.005	10,100	51		10/8/98	DH
MtBE	202	40	0.006	10,100	61		10/8/98	DH
MtBE	202	50	0.009	10,100	91		10/8/98	DH

# SUPPORTING DATA FOR TIER 1 SOIL ACTION LEVELS (SALS)

Drinking water source not threatened; annual rainfall = 400cm

Tier 1 SALS indirectly generated using SALS generated for drinking water sites (see HDOH RBCA document)

Contaminant	Tier 1 SAL for drinking-water source				Tier 1 SAL for drinking-water source not threatened		Date modeled	Modeled by
	Target GAL (mg/l)	Depth to gw (m)	threatened (mg/kg)	Conversion factor	threatened (mg/kg)			
MtBE	202	5	0.002	10,100	20		8/3/98	DH
MtBE	202	10	0.003	10,100	30		8/3/98	DH
MtBE	202	20	0.004	10,100	40		8/3/98	DH
MtBE	202	30	0.005	10,100	51		8/3/98	DH
MtBE	202	40	0.008	10,100	81		8/3/98	DH
MtBE	202	50	0.011	10,100	111		8/3/98	DH

Conversion Factor calculates: non-drinking water GAL/drinking water GAL

Soil action level calculated as: drinking water source threatened SAL x conversion factor